of a highly complicated nature, and it is now time that you pass into the great world to earn your own living.'' And so the young man passes out of the university without ever being even introduced to methods of research, or ever touching the boundaries of human knowledge. Being a university man, he hardly ever passes into the great world of affairs, but retires into the badly paid and despised teaching profession—and the worst of it is that *it is our very best students who invariably turn to the sheltered ranks of the teachers. It is only students who fail to pass the Chinese-like wall of examinations who join the business world and enter factory or workshop.* Perhaps, however, the young man, in spite of every discouragement meted out to him by the university authorities by means of suppressive legislation, is resolved to remain on in order to do research work. He works hard for two years longer (for research work is difficult and laborious), and at the end of that time has discovered enough to produce a small paper—nothing more can be expected after two years' work. Then as a rule this single little paper is not considered sufficient by the university authorities to merit the highest academic recognition, and so he leaves the university with no reward for his extra work. The highest academic honors involving recognition of research work are thus in this country confined to one class of men—namely, to university teachers, who remain on in the laboratories working out problems in science often for years; and the business world, *where the highest inventive and practical ability is really needed,* never or very seldom receives men trained in methods of research. The heads of factories or workshops, and even the directors of huge industrial undertakings, have never been introduced themselves either to the spirit or practise of research, and so are entirely out of sympathy with it. In Germany, however, a different system prevails, and it *pays* a student to remain on in order to undertake research, as it helps him afterwards in obtaining a good position in the industrial world. Such men gradually rise to the top, become directors of firms, and hence a sympathetic view of scientific work has become a characteristic of the German industrial world. It is all a matter of university legislation, and in Great Britain it is hopeless for the average student to attempt to obtain high academic honors involving research, and so he does not try. If any research work is done in this country research students must be *paid* to do it, the payment taking the form of research scholarships! In Germany a celebrated professor can have as many helping hands as he desires to carry on his investigations, his students forming willing and unpaid assistants, who afterwards pass out into the industrial world, carrying methods of research and influence there also. Here, however, students in any numbers can not be got to undertake or assist research going on in the university, for no good of it will come to them. There is nothing fundamentally different between the natures of German and English students. The difference in the enthusiasm for research, however, is that the legislations of the German and English universities are different, so that in Germany research work helps a student in getting a diploma, and so his living, whereas in this country it is of no practical advantage for a student to undertake research work.

SPECIAL ARTICLES

TWO DESTRUCTIVE RUSTS READY TO INVADE THE UNITED STATES[1]

The application of the adage, "an ounce of prevention is better than a pound of cure," to the spread of crop pests has now became an established procedure for the United States through the activities of the Federal Horticultural Board. One of the difficult factors in securing success is learning about pests before they have been introduced or have attracted much attention. The hollyhock rust did not seem important in the mountainous regions of Chili, but it spread over all the world between 1869 and 1886, reaching the United States last, doubtless due to our "splendid isolation" from South America in transportation facilities. The Colorado potato beetle, as another instance, had to leave its native home and food plants to become a recognized menace to crops. It seems worth while, therefore, to call attention to two rust fungi that seem to possess the possibilities of great harm, but which have not yet invaded the United States proper.

The peanut crop is a large and growing industry of the southern states. There is a rust of peanuts widely distributed in South America, and becoming common in the West India Islands. It is usually designated as

[1] Presented to the American Phytopathological Society at the St. Louis meeting, January 1, 1920.

Uredo Arachidis, although a single collection from Paraguay would indicate that it should be called *Puccinia Arachidis.* It has been known to mycologists since 1884, but only very recently has it attracted attention of the cultivator. Specimens received by the writer from W. Robson, of Montserrat, British West Indies, show every leaf covered with the abundant brownish-yellow powder of the fungus. This was in September, 1916. Mr. Robson reports that some seasons it is a serious menace to the peanut crop in that island. Experiments for its control with Bordeaux mixture did not prove promising.

The life cycle of the rust has not been worked out, but as in the case of the chrysanthemum rust the cultivator will meet only with the uredinial stage, for only one kind of spore is produced on cultivated plants. The rust appears to be working its way northward, having been reported from Porto Rico in 1913, and from Cuba in 1915. It has not yet been reported from any part of the United States proper.

The second rust, to which attention should be called, is one on potatoes and tomatoes (*Puccinia Pittieriana*). Little is yet known about it. It was collected by H. Pittier on the wild potato in 1903 and again in 1904 on the slopes of the volcano Irazú in Costa Rica, at an altitude of about 10,000 feet, and was found again in the same region by E. W. D. Holway in 1916. It is mentioned in Pittier's "Plantas Usuales de Costa Rica" under the name *Uredo Pittieri.* More recently specimens have been examined by the writer sent by A. Pachano from Ambato, Ecuador, where it was found in 1918 in the gardens of the Quinta Normal on both potatoes and tomatoes.

For this rust only one kind of spore, the teliospore, is produced in the life-cycle, and these spores germinate at once upon reaching maturity, requiring no period of rest. The habit of the fungus and its mode of distribution are essentially those of the hollyhock rust. In gross appearance, as well as in other characters, it is very similar to the common rust on cocklebur.

The two rusts, to which attention is particularly called, have not yet demonstrated their full capacity for harm, but from their appearance, and from what we know of the introduction and behavior of similar rusts that are highly destructive, there seems little doubt that if once established in a region where suitable crops are extensively grown, they will prove most unwelcome to the cultivator.

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THE FIXATION OF FREE NITROGEN BY GREEN PLANTS

IN spite of a considerable amount of negative evidence, the question of the ability of chlorophyll-containing plants to utilize the uncombined nitrogen of the air is still an open one. A large number of experiments with lower forms, especially the grass-green algæ, tend to disclaim any such ability and it has come to be very generally accepted that members of the Chlorophyceæ are not able to use free nitrogen. However, the number of species which have been investigated is small and the culture methods employed have not always been those which are most favorable for the best growth of these organisms. Accordingly experiments were begun in this laboratory a few years ago for the purpose of extending our knowledge over a larger number of species, under culture conditions which would insure a rapid and vigorous growth. Some of the results of these experiments are presented in this brief preliminary note and a more detailed account will appear elsewhere within a few months.

Seven species of grass-green algæ (Chlorophyceæ) were used in the experiments. With the exception of one (*Protococcus* sp.), all were isolated from soil and all species were used in pure culture, understanding by this term a single species free from all other organisms. The cultures were grown in 500 c.c. Kjeldahl flasks on approximately 150 gr. of accurately weighed mineral nutrient agar. Since previous experiments have shown that these forms will not grow in the complete